In Pursuit of a High Performance School

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ABSTRACT

Research relating to High Performance Schools shows a clear link between daylighting and student achievement. Schools which effectively use daylighting can significantly reduce their use of additional lighting and see clear gains in student achievement. This project was designed to examine the energy which may be conserved while adequate light levels are maintained by using available daylighting.

BACKGROUND

In 1998, the Heschong Mahone Study demonstrated that students who worked under the highest daylighting conditions experienced an average 21% increase in learning rates compared to students in classrooms with the least daylighting. These results were re-examined in 2002 as a result of questions raised by peer review and were again validated.

Electric lighting can account for 30-50% of a school building's electric power consumption. The High Performance School Building's philosophy is to design for high efficiency and visual comfort. One aspect of that is to integrate electric lighting and daylighting strategies. It is a long ingrained habit to walk into a room and turn on the lights without thought of how bright the room actually may be. In order to save energy, the lights need to be on only when needed. The chart below shows the daylighting codes at midday conditions.

Daylight Code 5 Classroom is adequately and uniformly lit with daylight, such that the teacher could successfully instruct with electric lights off, for most of the school year. 50+ footcandles available on most desks.

Daylight Code 4 Classroom has major daylight component and could occasionally be operated without any electric lights. Daylight may have strong gradient. 30± footcandles on many desks.

Daylight Code 3 Classroom has adequate levels in limited areas such as near windows. Some, but not all, electric lights could occasionally be turned off. 15± footcandles at some desks.

Daylight Code 2 Classroom has poor and/or very uneven daylight. Not likely to ever operate without electric lights fully on. 10± footcandles in limited areas.

Daylight Code 1 Classroom has minimal daylight. Very small and/or darkly tinted windows or inadequate top lighting. Not possible to operate without electric lights. 5± footcandles in limited areas.

Daylight Code 0 Classroom has no daylight.

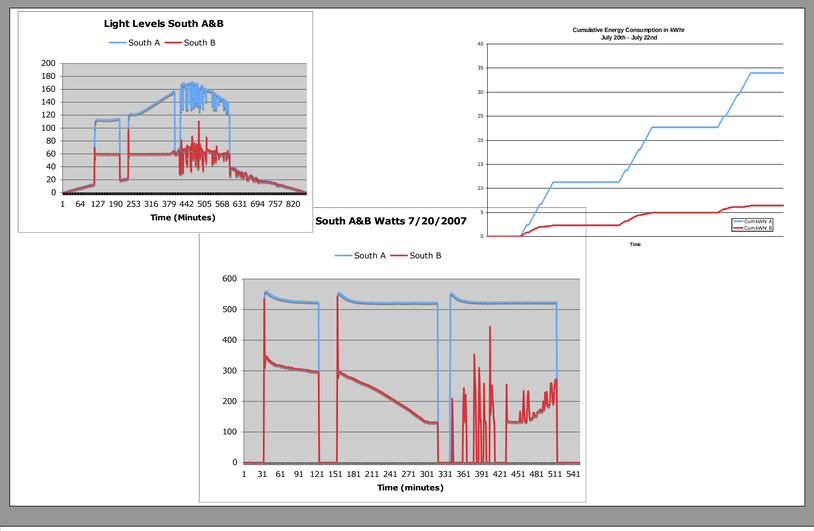
RESEARCH QUESTION/HYPOTHESIS

How much energy can be saved using available daylighting while still maintaining adequate light levels in the classroom?

METHODS

This study was set up at the Energy Resource Station. The facility has a set of 4 matched rooms which are oriented facing the East, South, West, and an interior pair of rooms with no outside light available. I chose to focus on the 3 outside pairs of rooms and also looked at window coverings as a way to make the daylighting more indirect. The East rooms had no window coverings blocking the direct rays of the sun. The South rooms had light filtering shades on both windows; and the West rooms had mini blinds set on horizontal. In the study, light levels were measured each minute in each room during the hours when students normally are in my classroom. When the light levels went above 60 lumens in the "B" rooms the lights dimmed until they were off. They stayed off until the light levels went down to 55 lumens at tabletop level.

The first day of the run there was a storm where a power outage affected the results. Therefore, I used the data from the next 3 days of the study.



RESULTS

Each of the 3 "B" rooms used fewer watts than the matching "A" rooms. East "B" lights never went on during the time of the study. That meant the "A" room used 11.35KWH of electricity and the "B" room used none. The southern exposure rooms with the shades that blocked 64% of the direct sunlight were less illuminated by daylight so both rooms used electricity although the "B" room used less. South "A" used 11.35 KWH and South "B" used 3.85 KWH. The difference was greater in the West rooms. West "A" used 11.32 KWH and West "B" used 2.55 KWH. The difference between conventional lighting and daylit rooms was 27.62 KWH saved during the 3 day test run.

DISCUSSION

The tests clearly showed that daylighting can lower the needed wattage of added light in a room. Over time, the savings could be significant. In the 3 day study, the "B" rooms used 81% less wattage than the "A" rooms. Added light in the "A" rooms raised the lighting to levels which exceed recommended work surface levels. Although this is not a bad thing, it is not the best use of energy. In the daylighting rooms, the lighting levels always stayed at 55 footcandles or higher, which is above the recommended level of 50 footcandles at work surface level in a classroom setting.

A concern with daylighting which showed up in the rooms was the issue of glare. With direct light streaming into the rooms, the computer screen placed in the room was often hard to see because of the glare from the sun. This could cause a problem for students working in a classroom setting. An issue with successfully saving energy by daylighting is the need to raise and lower light levels as the outside light increases or decreases. Daylighting is a topic highly studied in new construction, but more study is needed in existing structures to find the most efficient use of resources to gain the greatest level of learning.

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